Turbulent Entrainment-Mixing Processes in Cumuli

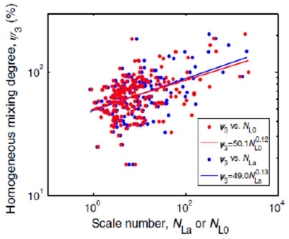
Research Highlight

Different turbulent entrainment-mixing processes (e.g., homogeneous and inhomogeneous) in clouds gives rise to distinct cloud properties, and thus understanding and representation of these processes are critical for improving large scale models, but still in its infancy. In particular, a general parameterization to cover a range of entrainment-mixing processes in cumulus clouds is still lacking.

DOE scientists at the Brookhaven National Laboratory, in collaboration with scientists in China, provide new insight by examining aircraft measurements collected by the U. S. Department of Energy's Atmospheric Radiation Measurement at the Southern Great Plains site during the RACORO field campaign and numerical simulations with the Explicit Mixing Parcel Model. The work is an extension of their study on stratiform clouds published in J of Geophys Res in 2013 to cumulus clouds.

The new study show that the empirical results in cumulus clouds are similar to those in stratocumulus clouds previously reported. Further examined are the effects of secondary mixing events with the Explicit Mixing Parcel Model (EMPM). The secondary mixing events are found to be at least partially responsible for the larger scatter in the above positive correlations based on observations than that in the previous results based on numerical simulations without considering secondary mixing events.

The results suggest an empirical parameterization of entrainment-mixing processes for models with two moment or higher microphysics schemes, and the potential of a unified parameterization of entrainment-mixing processes for stratiform and cumulus clouds. More research is underway to understand the subtle differences between stratiform and cumulus clouds and test the parameterization in atmospheric models.



Relationships between homogeneous mixing degree (#3) and two transition scale numbers (NLa, NL0), respectively. A larger homogeneous mixing degree means a higher degree of homogeneous mixing, and different values corresponds to different cloud microphysical relationships. The transition scale numbers can be calculated in models with two-moment or higher microphysics schemes. Definitions of homogeneous mixing degree and transition scale numbers were given in Lu et al. (JGR, 2013).

Reference(s)

Lu C, Y Liu, and S Niu. 2014. "Entrainment mixing parameterization in shallow cumuli and effects of secondary mixing events." Chinese Science Bulletin, 59(9), doi:10.1007/s11434-013-0097-1.

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Working Group(s)

Cloud Life Cycle